Instruction Manual

The Mega-Node
(NOise dioDE)

KAY ELECTRIC COMPANY
14 Maple Ave., Pine Brook, N. J.

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INSTRUCTION MANUAL

THE MEGA-NODE

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SECTION I

GENERAL DESCRIPTION

1.1 Introduction

The MEGA-NODE (NOise dioDE) is a calibrated random noise source, providing a selection of several output impedances with a choice of either balanced or unbalanced output.

The MEGA-NODE is a means for measuring the ratio of the noise power in a practical system to the noise power in an ideal system. This ratio is usually called Noise Figure [1, 2] which the MEGA-NODE measures directly in decibels.

The MEGA-NODE may be used for the measurement of

1. Noise Figure
2. Input Impedance
3. Receiver Sensitivity

Additional instruction sheets will be issued from time to time covering new and special applications or problems encountered by the users of this equipment.

1.2 General Characteristics

Dimensions: 8" high x 16" wide x 8" deep

Weight: 28 lbs. ≃ 14¼" without cabinet

Frequency Range: 5 to 220 mc

Output Impedances:

Unbalanced	Balanced
50 ohms	100 ohms
75 ohms	150 ohms
150 ohms	300 ohms
300 ohms	600 ohms

Noise Figure Range:

0 to 17 db. at 50 ohms
0 to 25 db. at 300 ohms

Filament Voltage Supply:

Filament voltage for the noise diode is d.c. supplied through a copper sulphide bridge rectifier from a voltage regulated source.

Plate Voltage Supply:

Diode plate voltage is d.c. supplied through a selenium bridge rectifier from a voltage-regulated source.

Power Supply Source: 117 volts ± 10%; 60 cycles A.C; 25 Watts

Fuse Protection: one type 3AG, 1 amp.

1.3 Physical Description

The MEGA-NODE is illustrated in the photograph of Fig. 1 and its schematic diagram and parts list given in Fig. 2. All controls, with the exception of the FILAMENT SET rheostat, are located on the front panel. The FILAMENT SET rheostat shaft is located on the chassis behind the meter. It is set only during preliminary adjustment and is not used during operation of the instrument.

The MEGA-NODE is constructed in two units, a power supply chassis and an r-f sub-assembly. These units are separately attached to the front panel and are removed with the panel for service. Screws which hold the power supply unit to the bottom of the cabinet must be removed together with the panel mounting screws to permit removal of the unit from its cabinet.

A six foot line cord is supplied with stowage space at the rear of the chassis inside the cabinet.

1.4 Noise Diode Tube

The noise diode supplied with this instrument is a Sylvania Type 5722 tungsten filament diode designed for use as a temperature-limited fluctuation noise generator at frequencies up to 400 mc.

1.5 Equipment Supplied

Quantity	Description
1	MEGA-NODE (NOise dioDE)
1	Adapter - Coax. fittings to twin lead - Balanced
1	Adapter - Coax. fittings to twin lead - Unbalanced
1	Instruction Manual
1	Coaxial ground fitting attached to panel by chain

1.6 Associated Equipment Required

To use the MEGA-NODE some indication of the noise output power of the receiver or amplifier under test must be provided. Several methods may be used. The most direct of these, Fig. 3, uses a power indicator, such as a square law r-f voltmeter or a thermo-couple or bolometer power meter. If

the device under test is a radio receiver, the amplifier shown in the diagram should be at i-f frequency, before the 2d detector (or the limiter in the case of FM). A sensitive receiver may have enough gain to operate a power level indicator directly. The power level instrument should be connected ahead of the 2d detector and, accordingly, must be capable of operating at i-f frequency.

If a square law r-f voltmeter is not available -- they are rare items -- a linear detector may also be used and simply calibrated to read in terms of power. While either a square or a linear voltmeter is usable, the voltmeter should not be a cross between the two unless it has been calibrated very carefully.

An alternative set-up, in which the voltmeter law need not be known, is illustrated in Fig. 4. A 3 db pad, which can be switched in and out, precedes the detector. Output readings are always taken at the same point on the detector meter scale. The meter characteristic is therefore unimportant.

If relative measurements are adequate -- there are many times during the development of equipment when this is true -- then detector law may be ignored in the interest of simplicity. The set-up of Fig. 5 is recommended in such cases.

Appendix A describes a method of measurement wherein the second detector of the receiver (in conjunction with a vacuum tube voltmeter) may be used directly even though its detection law is neither known nor readily capable of being calibrated. The method makes use of the MEGA-NODE itself as the calibration standard, and is applicable to many types of receivers.

SECTION II

OPERATION AND ADJUSTMENT

2.1 Preliminary Checks

Connect the line plug to 117 V. ± 10%, 60 cycle A.C. Turn power switch ON which should light the pilot light and the filament of the noise diode. Turn OUTPUT LEVEL control clockwise to increase diode filament brightness. Front panel meter should read about 40 ma (meter switch up) with the OUTPUT LEVEL control in maximum clockwise position.

2.2 FILAMENT SET Rheostat Adjustment

The FILAMENT SET rheostat is located on the chassis behind the meter. With the OUTPUT LEVEL control at maximum, the FILAMENT SET control should be set for full output of 40 ma on the panel meter with meter switch up. (A multiplying factor of 10 is used with the meter when switch is up). The FILAMENT SET rheostat will require adjustment from time to time as the filament of the noise diode ages.

CAUTION: TO LENGTHEN LIFE OF TUBE, DO NOT OPERATE WITH LARGE OUTPUT FOR LONG PERIODS OF TIME.

2.3 Connections for Operation

To connect the MEGA-NODE to equipment to be tested, use a short piece of transmission line whose impedance equals the impedance with which the equipment was designed to operate. This line should be as short as possible and connected to the MEGA-NODE with the proper connector fitting. Three fittings are supplied with the MEGA-NODE to handle all types of transmission line. They are:

a. The coaxial ground fitting, connected to the panel with a length of bead chain, is used to ground the center conductor of the lower BNC UG-290/U panel fitting. The upper BNC UG-290/U panel fitting is then used to connect coaxial transmission line to the unbalanced impedances, 50, 75, 150, and 300 ohms.

b. The unbalanced adapter fitting (the adapter fitting with the grounding skirt on the lower terminal) is used to connect to twin lead transmission line from an UNBALANCED receiver or amplifier input. Impedance values available are the same 50, 75, 150, and 300 ohms.

c. The balanced adapter fitting is used to connect to twin lead transmission line from a BALANCED receiver or amplifier input. The impedances available are 100, 150, 300, and 600 ohms. Two BNC coaxial connectors (using no adapter) may also be used, if desired.

The noise output power of the device under test is read on one of the indicators described in Section I.

2.4 Operation

a. Noise Figure Measurement

1. Connect MEGA-NODE to input of unit under test as outlined above. Set impedance switch to the correct value. Connect a suitable indicator to the output of the unit under test, as discussed in Section 1.6.

2. Turn the MEGA-NODE on and advance the OUTPUT LEVEL control until the output indicator meter reads well up on the scale, then adjust the TUNING knob for maximum output reading. The TUNING knob resonates the reactance of the plate circuit of the noise diode and also that across the output terminals of the MEGA-NODE. Generally the tuning peak will be very broad on all positions of the impedance switch except ∞ (Infinity).

3. Turn the MEGA-NODE off, and read the output meter. Then turn the MEGA-NODE on and advance its OUTPUT LEVEL control until the output indicator meter shows that the output power of the unit under test has been doubled. The Noise Figure of the unit is then read directly from the MEGA-NODE meter scale, adding impedance level corrections as given on the panel.

If the circuit of Fig. 4 is used, the initial reading (with MEGA-NODE off) will be with the 3 db pad switched out. Then with the MEGA-NODE on and the 3 db pad inserted, advance the OUTPUT LEVEL knob until the same output meter reading is obtained. This procedure, too, doubles the noise output power of the device under test.

b. Measurement of Input Resistance

Although the Kay Electric Co. recommends the use of its MEGA-MATCH frequency-scanning VHF Impedance Meter for measuring impedances, an approximate evaluation of the integrated input resistance of an equipment may be made by use of the MEGA-NODE. The method for doing this is described in the literature[3] and hence will not be repeated in detail here. It consists essentially of a procedure for comparing the input resistance of the device under test with one or more of the output resistance positions of the MEGA-NODE. Several precautions must be observed in applying this method however. First of all, the method does not yield information as to the input impedance - versus - frequency characteristics of the equipment being measured, but instead gives an effective "integrated" resistance value which is a function of the selectivity characteristic of the apparatus. The method is hence useful only when the input impedance of the device is purely resistive and of constant magnitude over the frequency band being passed by the apparatus under test. A second precaution is that the input terminals of the equipment being measured should be connected directly across the output terminals of the MEGA-NODE to make this method completely valid. Otherwise, the connecting leads will cause an impedance transformation effect to take place which will result in an error in measurement. The only exception to this is when the connecting leads constitute a lossless transmission line of characteristic impedance exactly equal to the input resistance of the equipment being measured. It is obvious, of course, that once such a transmission line is found the input resistance of the device under test is automatically known.

SECTION III

TECHNIQUE OF MEASUREMENT

3.1 The Output Meter

a. For Noise Figure measurements, [4,5] the relative noise power output of the equipment under test must be evaluated. The output meter must, therefore, be a device capable of indicating random noise power RATIOS. For best accuracy it is desirable to use a meter responding to R.M.S. voltage or current values. Linearity of the indicator and of auxiliary equipment may be determined by first introducing, with the MEGA-NODE, a noise input level known to be considerably (i.e., at least 8 db) higher than the internal noise level of the unit under test and then doubling the noise diode d-c plate current, thus doubling (i.e., increasing by 3 db) the input noise power. The resultant change in deflection of the output indicating device is then a measure of the 3 db change in noise power output from the equipment under test. This calibration should be performed with gain of the system reduced to that point wherein the operating level of the output indicating device is the same as for the ensuing Noise Figure measurement.

b. Almost any indicating device may be used following the detector provided that an insertion loss pad of 0-db and 3-db be made available for use just ahead of the detector. The pad is first set at 0-db for the condition of no noise input being derived from the MEGA-NODE, and the output indication is noted. The 3-db section is then inserted and the noise signal from the MEGA-NODE is turned up to provide the same output reading as before. The noise figure of the equipment under test is then read directly in db from the MEGA-NODE meter scale, adding the proper correction factor for impedance level as given on the panel. In using the pad described above, care must be taken that its insertion does not affect the bandpass or gain characteristic of the unit under test. A meter directly across the output of the i-f amplifier may be used as the indicating device provided the meter is substantially flat to above the i-f frequency and reads R.M.S. values.

3.2 Hum Considerations

It is important that the output indication corresponds to random noise rather than to hum. A convenient method for checking this is to short circuit the output of the last tube which contributes significant noise to the system. The output indication should fall to zero. This test will not account for hum components introduced prior to the short circuit. However, such hum components are normally small enough not to affect the measurement. Their presence, if suspected, may be determined by the temporary introduction of additional filtering or the observation of the noise output on a high gain oscilloscope. The use of bridge type hum filters, 60 cycle and 120 cycle, may be desirable and helpful.

3.3 Conditions of Measurement

a. The reactive component of the receiver input impedance should be tuned out for accurate Noise Figure measurements. This condition is satisfied by the proper adjustment of the TUNING control of the MEGA-NODE. However, if the i-f amplifier following the front end under test is broad-band it will probably be difficult to cancel the receiver input reactance over the total bandwidth, particularly if the input circuit of the receiver is of the variably tuned type. It may be necessary to replace the broad-band i-f amplifier with a narrow-band amplifier. The Noise Figure may then be measured at a number of frequencies in the r-f pass band and the results plotted to give the overall noise picture.

b. All stages prior to the indicator must be linear and overload must not occur with even the highest noise input it may be necessary to employ.

c. There must be sufficient overall gain in the Noise Figure measurement set-up to produce across the terminals of the output indicating device enough energy attributable to the effective input noise sources in the device under test to give a usable output reading or deflection. For overall band widths of the order of 4 mc. this will generally require at least 80 db of overall gain.

SECTION IV

THEORY OF OPERATION

4.1 General Considerations

The "noise diode" method of measuring receiver Noise Figures is quite fundamental, and permits simplification in procedure and greater accuracy than other methods. Techniques employing a continuous-wave signal generator are subject to a noticeable error in the measurement of the extremely small power levels employed, especially at the higher frequencies, and a separate measurement of receiver bandwidth is required. The use of a temperature-limited diode as a noise generator permits cancellation of the bandwidths involved since the diode noise is distributed the same as the receiver noise with respect to frequency. The method hence required no measurement or knowledge of bandwidth nor of gain. The mean squared noise current supplied by the diode is proportional to the direct plate current which can be easily and accurately measured.

4.2 Noise Figure Measurements

Any receiver, other than a hypothetical ideal receiver, will have noise generated within the receiver itself in addition to the noise supplied by the signal source. The Noise Figure is a figure of merit by which the noise of a given receiver system is compared with that of an ideal receiver in a similar system but having the same bandwidth. The noise supplied to the ideal receiver by the signal source will be the thermal noise developed in the internal resistance of the source

$$e_t^2 = 4KTR_a\Delta f \qquad (1)$$

Where:

e_t^2 = Open-circuited mean squared thermal noise voltage

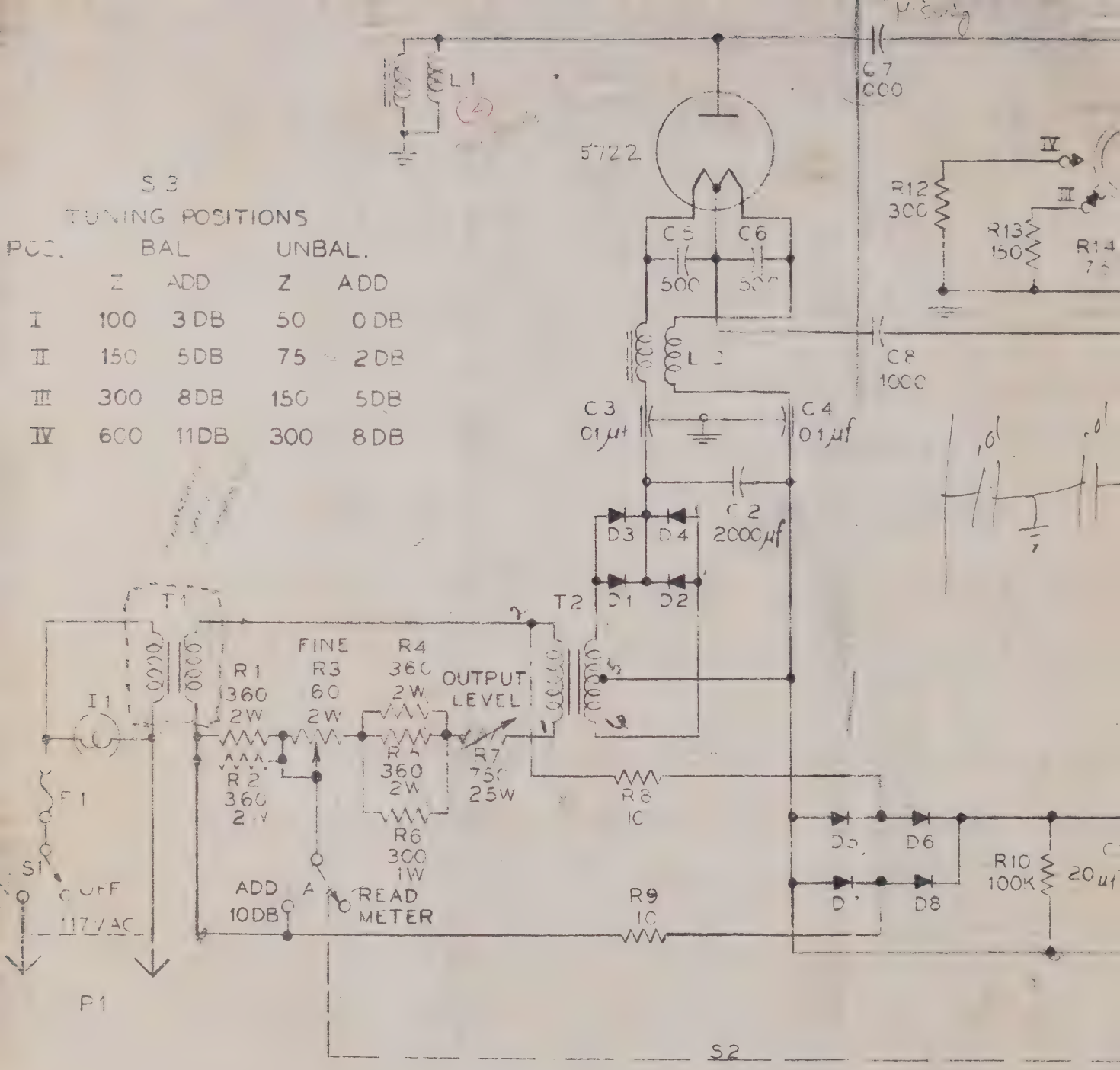
K = Boltzmann's constant, 1.37×10^{-23} joules/^oK

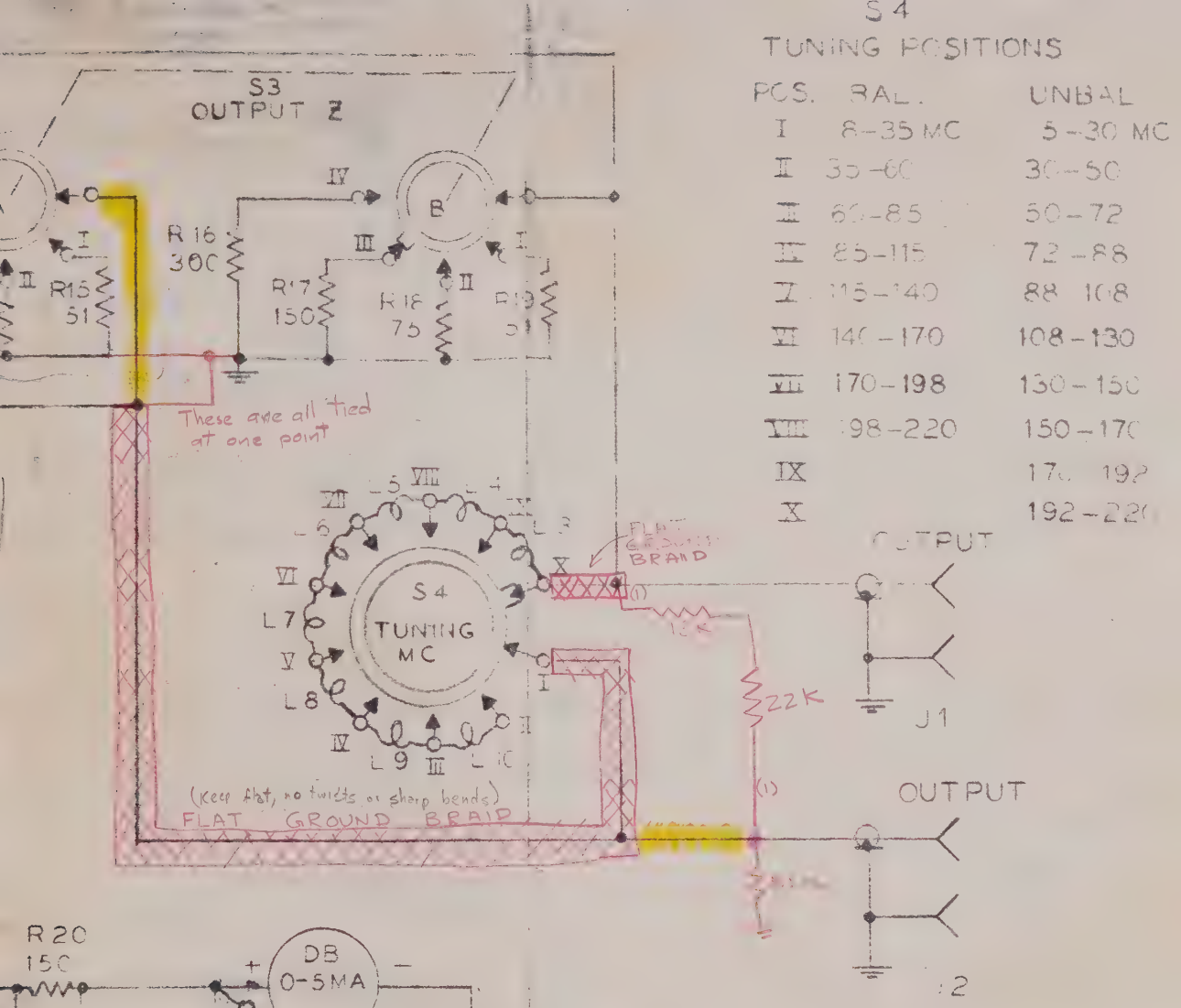
T = Temperature of resistance in degrees Kelvin

R_a = Internal resistance of the source in ohms

Δf = Receiver noise bandwidth in c.p.s.

The noise present in the given receiver will be that supplied by the signal source plus the noise generated within the receiver itself. The noise generated within the receiver may be referred to the signal source as a mean squared noise voltage. Call this voltage e_n^2.

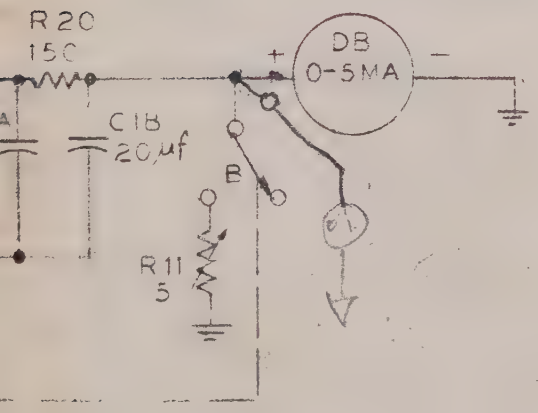

S 3
TUNING POSITIONS
PCC.
BAL
UNBAL.
Z
ADD
Z
ADD
I 100 3 DB 50 0 DB
II 150 5DB 75 2 DB
III 300 8DB 150 5DB
IV 600 11DB 300 8 DB
L1
5722
C5
C6
500
C7
000
C8
1000
L2
C3
01 µf
C4
01 µf
C2
2000µf
D3
D4
D1
D2
T1
T2
I1
R1
360
2W
FINE
R3
60
2W
R4
360
2W
OUTPUT
LEVEL
R2
360
2W
R5
360
2W
R6
300
1W
R7
25W
R8
IC
R9
IC
F1
S1
OFF
117 VAC
ADD
10DB
A
READ
METER
D5
D6
D7
D8
R10
100K
20 µf
IV
III
R12
300
R13
150
R14
P1
S2



S4

TUNING POSITIONS

POS.	BAL.	UNBAL
I	8–35 MC	5–30 MC
II	35–60	30–50
III	60–85	50–72
IV	85–115	72–88
V	115–140	88–108
VI	140–170	108–130
VII	170–198	130–150
VIII	198–220	150–170
IX		170–192
X		192–220



NOTE – EXCEPT WHERE NOTED
ALL RESISTANCES IN OHMS
ALL CAPACITANCES IN μμf

(1) Keep leads very short

(2) Test the modification with a grid dipper. Move L1 around to get a dip at 246 MC with S4 in position X. Check for a dip at 30 MC with S4 in position I.

SCHEMATIC — MEGA-NODE

MAT. | FINISH: | SCALE:

DIMENSIONS TOLERANCES UNLESS OTHERWISE SPECIFIED:
DECIMAL DIMENSIONS ± .002 FRACTIONAL DIMENSIONS ± .005

CHANGE	DATE	APP.
C R20 Added	6-20-5	[illegible]

KAY ELECTRIC CO.
PINE BROOK, N. J.

DWN BY A WPIER[illegible] | DATE 4-[illegible]
APP. BY K.S. | DATE 4-12-[illegible]

DWG. NO. KB 1[illegible]

Then by definition:

$$\text{Noise Figure} = F = \frac{e_n^2}{e_t^2} \qquad (2)$$

To determine e_n^2 the "noise diode" is connected to the receiver through the signal source impedance, R_a. With the noise source turned off, the noise power output of the receiver is measured. Then the noise source is turned on and the diode direct plate current is increased from its lowest value to that value which just doubles the receiver noise power output. The mean squared noise current of the diode is given by

$$i^2 = 2\, e\, I_b \Delta f \qquad (3)$$

Where:

i = root mean squared noise current in amperes

e = charge on electron (1.59×10^{-19} coulombs)

I_b = D.C. diode plate current in amperes

Δf = the noise bandwidth of the receiver in c.p.s.

The mean squared voltage developed by this noise current across the internal impedance of the source (R_a) will be

$$e_n^2 = (iR_a)^2 = 2\, e\, I_b \Delta f\, R_a^2 \qquad (4)$$

Substituting equations (1) and (4) in equation (2)

$$F = \frac{e\, I_b\, R_a}{2KT} \qquad (5)$$

It is usually permissible to assume T to be room temperature, i.e. 288° Kelvin, 17° C., 63°F., in which case equation (5) reduces to

$$F = 20\, I_b\, R_a \qquad (6)$$

Variation of this reference temperature between 270°K and 300°K ordinarily will affect the Noise Figure by less than about $\pm$ 5 percent, which is equivalent to $\pm$ 0.2 db. The value of F given by (6) is a power ratio. It may be expressed in db by the relationship.

$$F_{db} = 10 \log_{10} F \qquad (7)$$

4.3 Requirements of the "Noise Diode" Generator

a. Resistor R_a which is taken as the internal impedance of the signal source must be constant over the noise bandwidth of the receiver. This has been accomplished in the MEGA-NODE by keeping its output capacitance as low as possible and by tuning it out by means of TUNING inductor L3.

b. The "noise diode" must be fully temperature limited. This is a condition of equation (3) and it is well to observe that the a-c plate resistance of the diode, which shunts R_a, is sufficiently high to be negligible only when the diode is completely temperature limited. This condition is met in the MEGA-NODE for all values of diode direct plate current less than about 50 milliamperes.

4.4 References

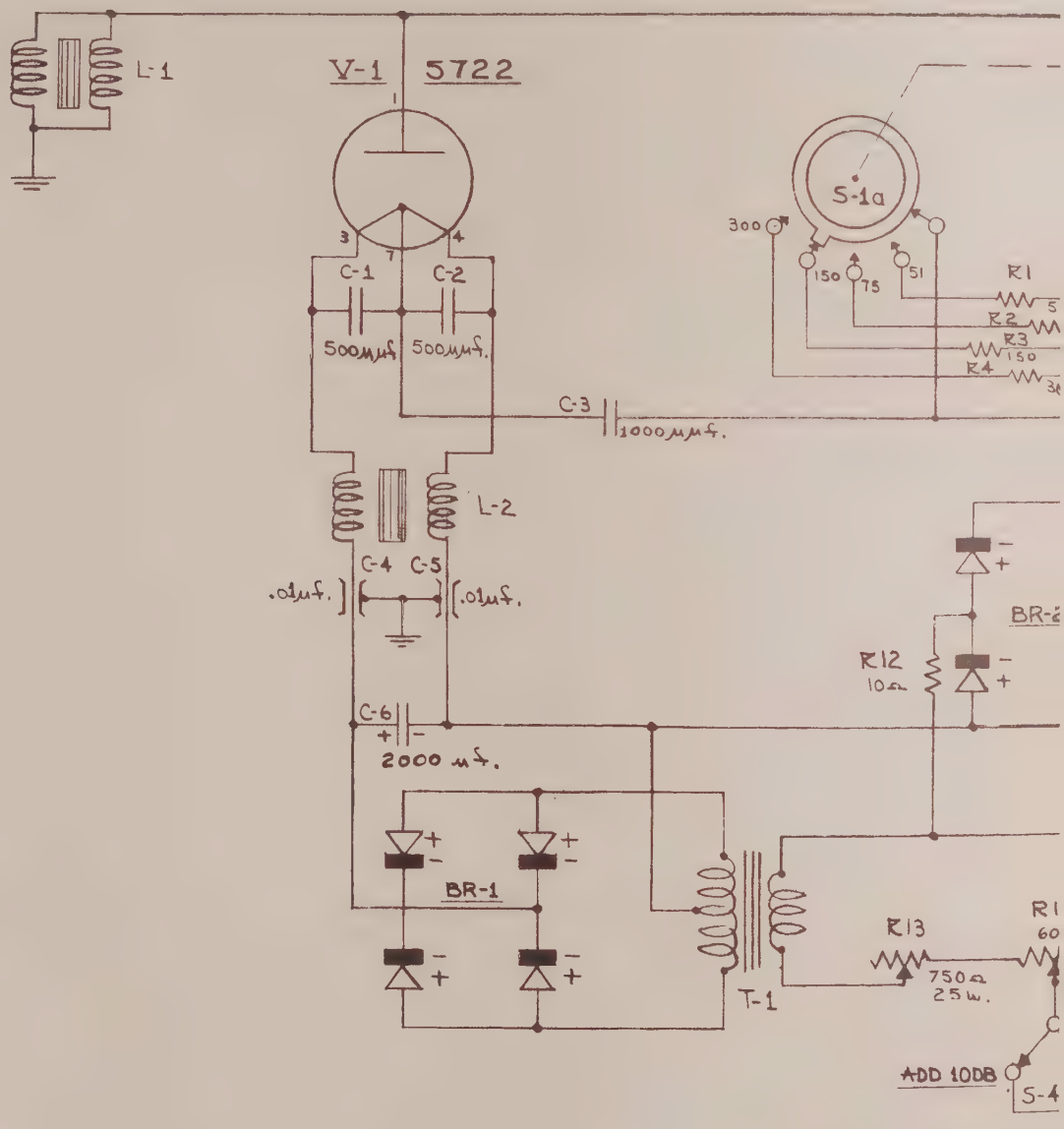
(1) D.O. North, "The Absolute Sensitivity of Radio Receivers", RCA Review, vol. 6, pp. 332 - 344; January, 1942.

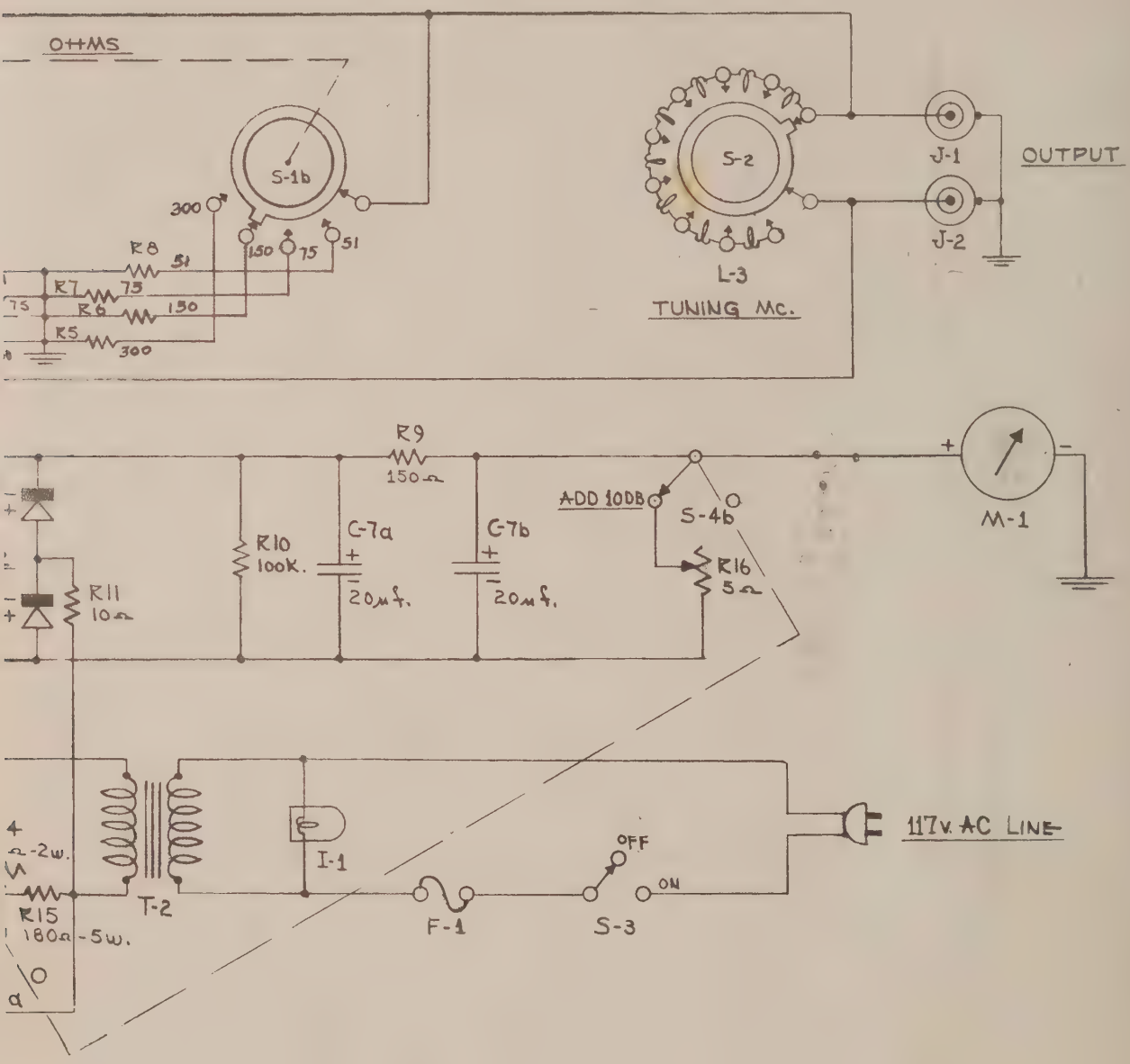
(2) H.T. Friis, "Noise Figures of Radio Receivers", PROC. IRE, vol. 32, pp. 419 - 422; July, 1944.

(3) P.G. Sulzer, "Noise Generator for Receiver Measurements", Electronics, vol. 21-7, pp. 96 - 98; July 1948.

(4) H. Goldberg, "Some Notes on Noise Figures", PROC. IRE., vol. 36, pp. 1205 - 1214; October 1948. Reference is made in particular to pp. 1210 and 1211.

(5) De Witt and Stodola, "Detection of Radio Signals Reflected from the Moon", PROC. IRE., vol. 37, pp. 229 - 242; March 1949. Reference is made in particular to pp. 235 and 236.


L-1
V-1 5722
1
3
4
7
C-1
C-2
500μμf.
500μμf.
C-3
1000μμf.
L-2
C-4 C-5
.01μf.
.01μf.
C-6
2000 mf.
BR-1
T-1
S-1a
300
150
75
51
R1
R2
R3
150
R4
R12
10Ω
R13
750Ω
25w.
ADD 10DB
S-4



MEGA-NODE SCHEMATIC FIG.#2

MAT.	FINISH:	SCALE:

DIMENSIONS TOLERANCES UNLESS OTHERWISE SPECIFIED:
DECIMAL DIMENSIONS. ± .002 FRACTIONAL DIMENSIONS ± .005

CHANGE	DATE	APP.
REVISED & REDRAWN BY: J.L.K.	4/22/53	
APPROVED BY: I.S.	4/23/53	
"A" R5-6-7-8-13-14 Changed size AWP		
C-3-6 " " "	12/6/55	

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PINE BROOK, N. J.

DWN. BY Jack Kunick DATE 4-22-53
APP. BY IS DATE 4-23-53

DWG. NO. KB-1558 A

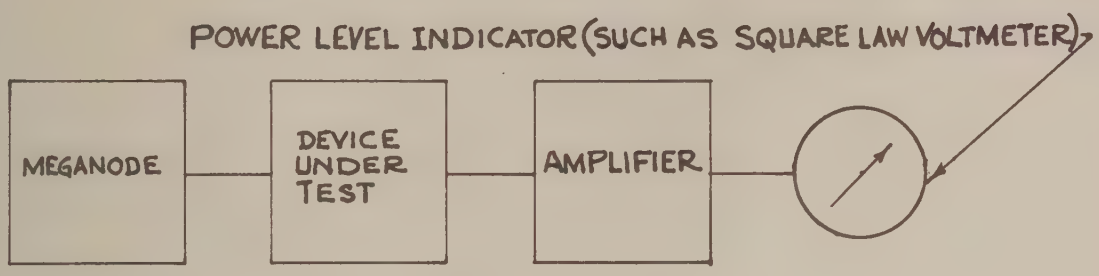


FIG 3. NOISE MEASUREMENTS WITH POWER LEVEL INDICATOR

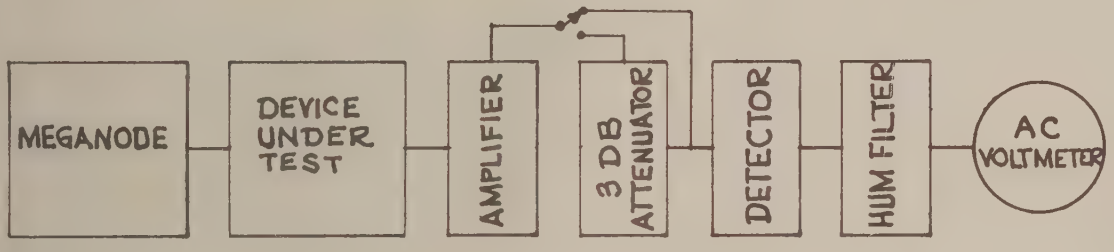


FIG 4. MEASUREMENT WHERE VOLTMETER LAW IS UNKNOWN

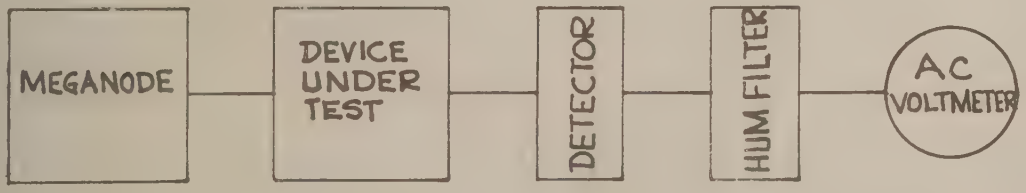


FIG 5. SET-UP WHEN ONLY RELATIVE MEASUREMENTS ARE REQUIRED

MEGA-NODE

APPENDIX A

Log-Log Graphical Method of Evaluating Noise Figure

This method is applicable where the noise figure of the device under test is comparable in value to that corresponding to the maximum output capabilities of the MEGA-NODE. It is also useful in those cases where neither a r.f. voltmeter or power meter (Fig. 3) nor a 3 db attenuator pad (Fig. 4) is readily available. It involves the use of the output voltage developed by the second detector of the equipment under test (provided the detector is of the diode type) as the measured quantity, thus permitting the use of a d.c. type of V.T.V.M. such as is commonly available in most laboratories. The set-up of equipment is similar to that shown in Fig. 5 with the exception that the V.T.V.M. (connected across the diode detector load resistor) replaces the hum filter and A.C. voltmeter shown.

The procedure is best explained by means of an illustrative example, and the various steps are given below:

1. Set up the equipment as discussed above.

2. With the MEGA-NODE off and with the amplifier tube just preceding the second detector removed, measure the residual d.c. voltage across the detector load resistor. This voltage is caused by a combination of "contact potential" and electron initial emission velocities, and its value is to be subtracted from all subsequent voltage readings prior to plotting them. Let us say this voltage reading is 0.3 volts.

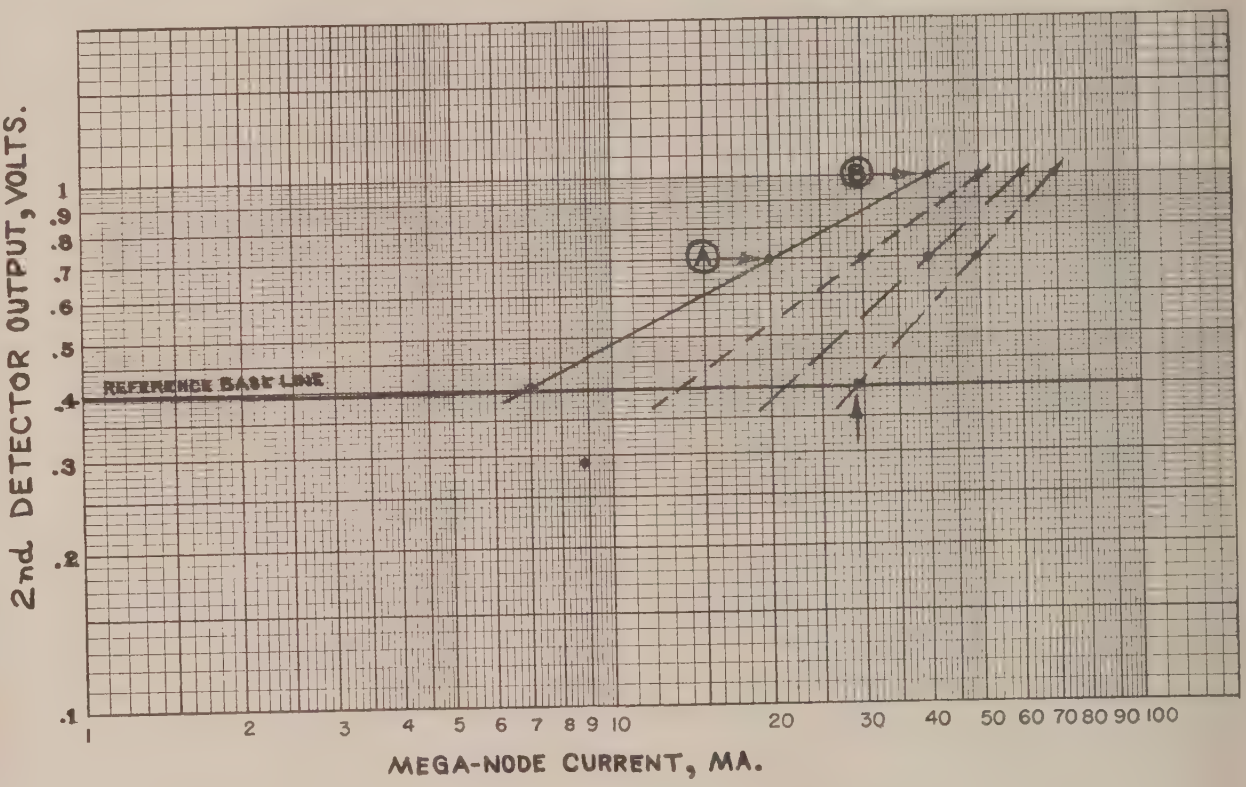
3. Replace the amplifier tube removed above, and, with the MEGA-NODE still off and with amplification of at least 80 db provided as discussed in Section 3.3c, read the developed detector voltage. This reading should be at least double the previous "residual" reading if the amplification value noted above has been met. Let us say the voltage reading for this step is 0.7 volts.

4. With the MEGA-NODE on, turn its OUTPUT LEVEL control up to give a noise diode d.c. plate current of 40 ma. Next, adjust the TUNING knob of the MEGA-NODE for maximum 2nd detector output as read on the V.T.V.M. Let us say this maximum output voltage measures 1.3 volts.

5. Turn the OUTPUT LEVEL control down to give a noise diode d.c. plate current of 20 ma. and read the 2nd detector V.T.V.M. Let us say this reading is 1.0 volt.

6. Subtract the 0.3 volt "residual" reading of step 2 from each of the subsequent readings, steps 3, 4 and 5. This gives readings of 0.4, 0.7 and 1.0 volts respectively.

7. Using log-log graph paper with MEGA-NODE current as the abscissa and 2nd detector voltage as the ordinate, plot a horizontal line at the 0.4 volt level as a reference base line, and plot the (0.7 volt, 20 ma.) point and the (1.0 volt, 40 ma.) point as shown at A and B respectively of the figure below.



8. The problem is to find now by graphical trial-and-error an incremental noise diode current value which, when added equally to points A and B, yields a new pair of points a straight line through which then intersects the REFERENCE BASE LINE at a current value exactly equal to the incremental current value.

9. Let us first try an incremental current value of 10 ma. When this value is added equally to points A and B we get two new points, (0.7 volt, 30 ma.) and (1.0 volt, 50 ma.) A straight line drawn between these points (the short-dashed line in the figure above) intersects the REFERENCE BASE LINE at about 13.4 ma., which is larger than the chosen incremental value. This indicates that a larger incremental value should be tried.

10. Trying an increment of 20 ma., we get points (0.7 volt, 40 ma.) and (1.0 volt, 60 ma.) A straight line through these points (the long-dashed line in the figure above) produces an intercept at about 21.5 ma. A still larger incremental value must hence be chosen.

11. Trying an increment of 29 ma., we get points (0.7 volt, 49 ma.) and (1.0 volt, 69 ma.) A straight line through these points (the long-short-dashed line in the figure above) intersects the REFERENCE BASE LINE at exactly 29 ma., corresponding to the incremental value chosen. This is the correct value of noise diode current to use in calculating the Noise Figure of the device under test. At the same time, the slope of the final plotted line gives directly the rectifier power law of the second detector used in the set-up when it is noted that this final line is essentially that of rectified detector output voltage versus total noise power applied to the detector. A 45 degree slope (i.e., tan = 1) would thus indicate that the detector was of the so-called "square law" type, while a 26.6 degree slope (i.e., tan = 0.5) would indicate a linear detector.

MEGA-NODE

APPENDIX B

DETAILED METHOD OF NOISE FIGURE MEASUREMENT ON TELEVISION RECEIVERS

I. MEASUREMENT TECHNIQUE

In order to use the Mega-Node it is necessary to read the output power of the system. This cannot be done with a peak or average reading instrument even though it is calibrated .707 peak and called an RMS meter. Because power is directly proportional to the mean square voltage, a thermal type indicator is the best output measuring device. In the case of a television receiver the noise power is conveniently measured at the output of the IF amplifier before the signal has been detected. An instrument well suited for this work is a sensitive bolometer. One such unit is the Hewlett-Packard Model 430-A Microwave Power meter which measures power levels as small as .01 Milliwatt. Although noise figure measurement of the tuner alone is desired, it is necessary to raise the noise power output level for purposes of measurement. This can be done most nearly approximating conditions of tuner operation by using a television IF amplifier. To avoid obscuring the noise measurement of the front end, the IF amplifier should be relatively free of noise and regeneration. Setting of the "fine tuning" control may also vary the noise figure to a slight degree. For purposes of standardization the tuner should be adjusted to the center of the television channel using a sweep signal generator.

Actual measurement is made with the instruments arranged as shown

1. Apply operating voltages to all units.

2. With a sweep signal generator set the tuner at the center of the channel.

3. Set the output control of the Mega-Node at minimum (full counterclockwise), and select the proper source resistance (usually 300 ohms balanced).

4. Adjust the bolometer unit to measure output noise power; turn off the Mega-Node.

5. Read noise output power.

6. Turn on the Mega-Node and increase the output level until the power indication of the bolometer is exactly doubled. Turn off the Mega-Node to check the original noise power and, if necessary, recheck the zero of the bolometer. When "turning on" the Mega-Node just doubles the bolometer reading, the noise figure may be read from the Mega-Node directly in decibels. This reading must be corrected by adding the number of decibels indicated at the "impedance" control for balanced or unbalanced operation. Check the meter-scale knob position and add 10 db if necessary.

II. PRECAUTIONS FOR ACCURACY

In order to insure accuracy of measurements on high gain systems it is necessary to observe several precautions:

1. Feed-Back

There must be no feed-back in the system not present under normal operating conditions. The barreter for the bolometer bridge should be placed very close to the last amplifier tube in the IF strip, and connection to the bridge from the barreter should be made with shielded cable. Shielding should be as effective as possible.

2. Pickup

Since the system to be measured has extremely high gain, the presence of any high-frequency fields, particularly those of nearby television stations, can cause inaccuracy. In order to reduce this possibility, measurement should be made in a screen-room. If this is impossible, the output should be checked carefully to make certain that only thermal noise is present.

3. Bias and Automatic Volume Control

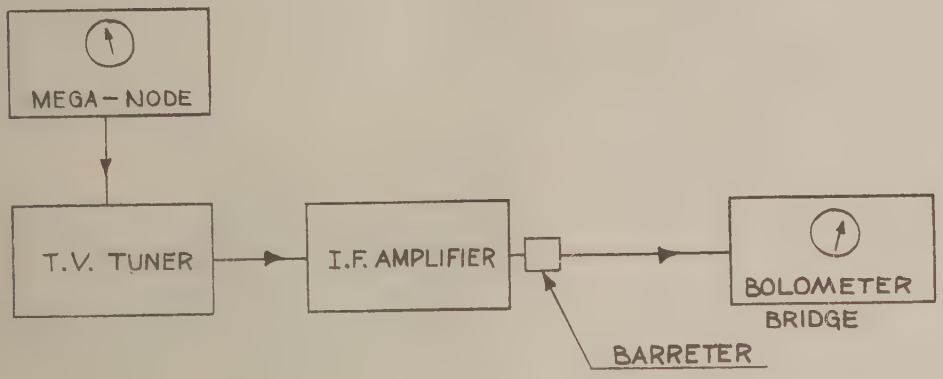
The automatic biasing controls of the tuner and IF amplifier should be disabled. Normal bias present at zero signal input (for purposes of standardization) should be applied to the tubes from a battery supply. Bias supplies operating from power lines are not desirable because of likelihood of high noise voltages and the possibility of pickup and hum.

4. Hum

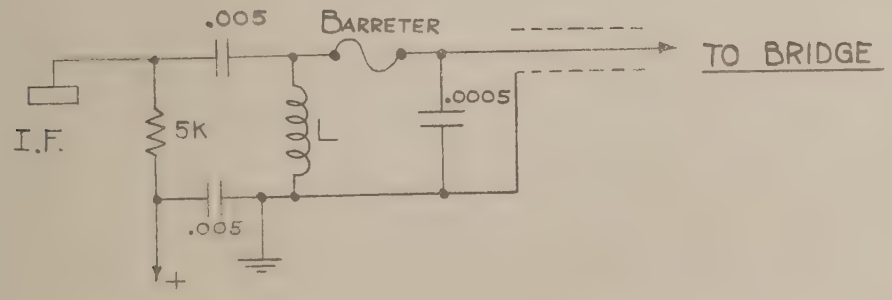
Introduction of hum in the system can completely mask noise voltages and must be avoided. This is aided by a coupling network with poor low frequency response used to supply power to the barreter.

NOISE FIGURE MEASUREMENT

BLOCK DIAGRAM



BARRETER SCHEMATIC



"L" RESONATES I.F. WITH STRAY CAPACITANCE
NOT CRITICAL

5. Series Lead Reactance

It has been found that the unavoidable series lead reactance present between the terminating resistors and panel connectors will affect the position of the tuning switch when operating at impedance levels below 300 ohms. The panel markings "Tuning, MC" are correct for 300 ohms, the usual television antenna impedance. (White balanced and red unbalanced). However, to obtain minimum S. W. R. it is necessary to adjust the tuning switch to a different position for the same operating frequency at other impedance levels (for example, 50 ohm unbalanced). The attached table gives the correct tuning switch positions.

6. IF Amplifier Noise

While the usual Tuners and IF amplifiers associated with television receivers will not give trouble from this cause, it is possible for an extremely noisy IF amplifier to control the noise-figure of the system, rather than the tuner. This can be quickly checked by measuring the output noise with the Mega-Node turned off; then remove plate voltage from all tubes in the tuner, still allowing the IF amplifier to function. The noise power under these conditions should be very much smaller than the normal operating noise output of the system.

7. Limiting

A check should be made to ascertain that the noise is not limited by overloading of the IF amplifier. Operation in the linear region is essential for accurate measurements.

8. AC-DC Tuners

A line isolating transformer should be used for tests of AC-DC equipment.

IMPEDANCE LEVEL AND CONNECTION

Desired Operating Frequency Megacycles	50 unbal. Read Red Marking Set Switch To	75 unbal. Read Red Marking Set Switch To	150 unbal. Read Red Marking Set Switch To	150 bal. Read White Marking Set Switch To	300 ohms all Positions
5-30	5-30	5-30	5-30	8-35	Marking
30-50	30-50	30-50	30-50	8-35	On Front
50-72	30-50	30-50	30-50	35-60	Panel
72-88	50-72	50-72	50-72	35-60	is
88-108	50-72	72-88	50-72	60-85	Correct
108-130	50-72	72-88	72-88	60-85	
130-150	50-72	88-108	88-108	85-115	
150-170	72-88	88-108	88-108	85-115	
170-192	72-88	108-130	108-130	85-115	
192-220	88-108	108-130	108-130	115-140	

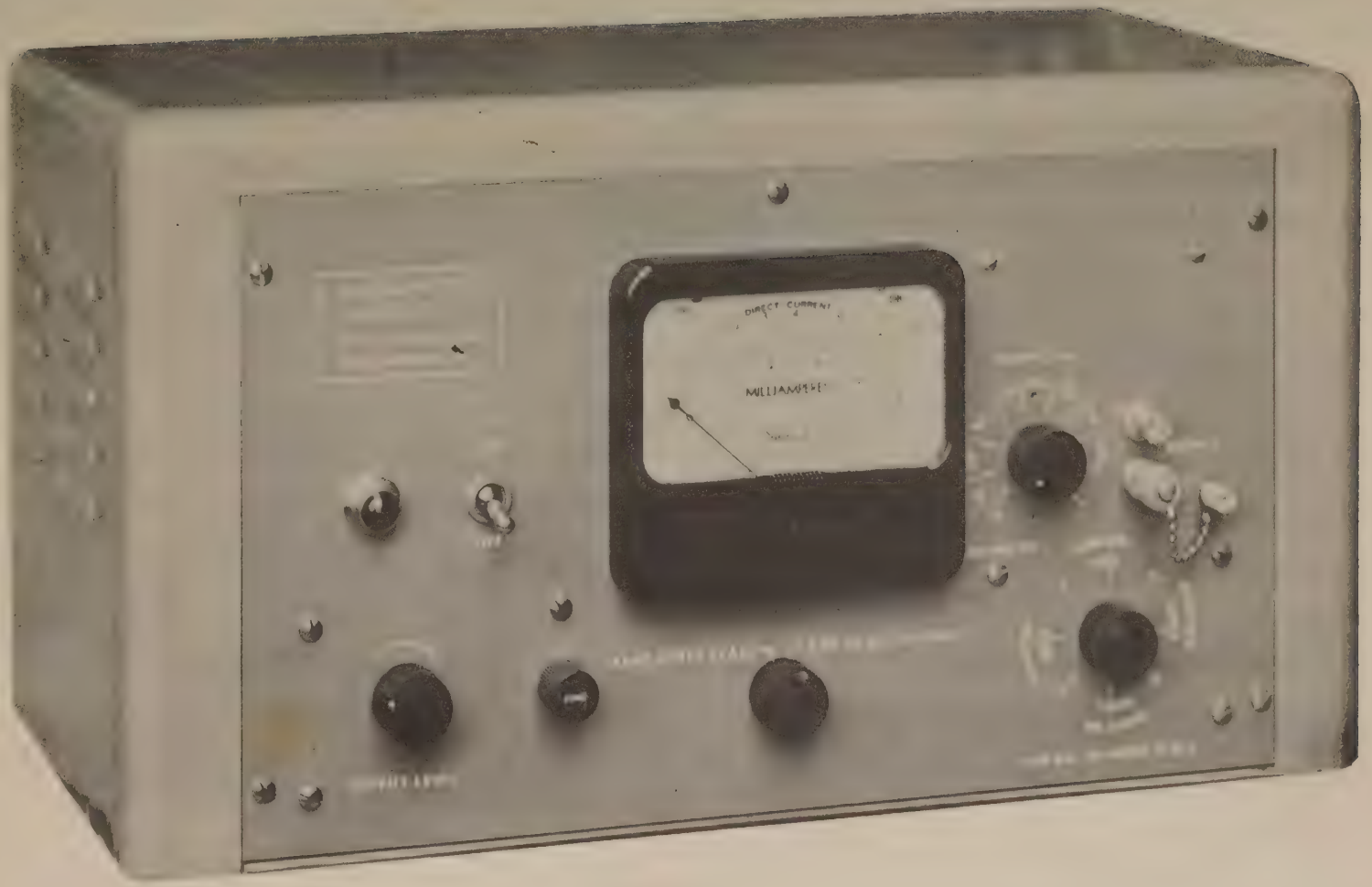


FIGURE 1

MEGA-NODE
PARTS LIST

Tubes

V-1	#5722

Resistors (All resistors 1/2 watt unless otherwise specified.)

R-1	51
R-2	75
R-3	150
R-4	300
R-5	300
R-6	150
R-7	75
R-8	51
R-9	150
R-10	100,000
R-11	10
R-12	10
R-13	750 , 25 watts, pot.
R-14	60 , 2 watts, pot.
R-15	180 , 5 watts
R-16	5 , pot.

Condensers

C-1	500 μμf, 500V
C-2	500 μμf, 500V
C-3	1000 μμf, 500V
C-4	.01 μf, 400V
C-5	.01 μf, 400V
C-6	2000 μf, 12V
C-7a & 7b	20 μf Electrolytic, 250V

Transformers

T-1	Special Filament
T-2	Sola #30804 Regulating

Coils

L-1	Spec. Bifilar Choke
L-2	Spec. Bifilar Choke
L-3	Spec. Variable (Tuning)

Jacks

J-1	625/U (A/N)
J-2	625/U (A/N)

Switches

S-1a & 1b	Spec. Rotary Switch - ohms
S-2	Spec. Rotary Switch - ohms
S-3	S.P.S.T. Switch - ON-OFF Line
S-4a & 4b	Spec. Rotary Switch - ADD 10 db

Pilot Lamp

I-1	G.E. #NE51, 115V, AC

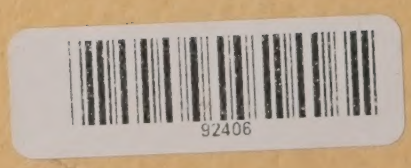
Fuse

F-1	3 amp.

Meter

M-1	Special

Rev. 8/25/53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